"CONNECT" - NEW JERSEY PACKET RADIO NEWSLETTER
C/O B.B. RILEY KA2BQE
RD #2 BURNT HOUSE ROAD
INDIAN MILLS, NEW JERSEY 08088

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NEW JERSEY PACKET RADIO CONTACT PERSONNEL

NORTH
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EAST
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30 VICTORIA PLACE
RED BANK, NJ 07701
201-741-1151

CENTRAL
BILL ASHBY K2TKN
BOX332
FLUCKEMIN, NJ 07978
201-658-3087

SOUTH
BRIAN RILEY KA2BQE
RD 2 BURNT HOUSE ROAD
INDIAN MILLS, NJ 08088
609-268-1505

* * * CONNECT - New Jersey Packet Radio Newsletter * * *
FEBRUARY 1982

Here we are in our second issue. A lot has happened in the short interval since our inaugural issue went out. The New Jersey Packet Radio Group has forged ahead in several leaps. We now have three Vancouver boards running and three that will be running by the time this is read. The Cherryville group is up and running 1200 baud afsk ASCII on 220 band, using the General Datacomm modems. A large number of WB2CAM's Decwriters are out and running also. This author is the proud owner of one - I might add that the unit came up and running 'as-is' the day I got it from Gordon.

The big happening was the tele-conference with the Phoenix Group. On Saturday the 6th of Feb we linked up on 15m/2m with KD2S et al. For our Sunday nite regular net on the Cherryville 147.375/.975 we also patched Tucson in via Ma Bell. This looks to be a great source of information interchange between groups. Allowing each to present the others with their views and accomplishments.

I intend to alter the structure of the newsletter considerably. We will begin disseminating the 'news' part of the letter through electronic means. Weekly I will post news and small technical items to various computer bulletin boards in New Jersey. The hard technical materials will be published about every six weeks in a mailed newsletter. The weekly bulletins will also contain lists of resource material (software listings, schematics, etc) that me sotten immediately via an SASE. It is our present plan to post the newsletter to the following CBBS setups;

AMRAD - Washington, DC - 703-734-1387
Terry Fox WB4JFI
110,300,450,600 - Bell 103

(RATS) - Parsippany, NJ - 201-887-8874
Mike Freidman WB2WNX
300,1200 Bell 212

(RATS) - Little Falls, NJ - 201-785-3565
Gordon Beattie WB2CAM
300,1200 Bell 103/212

(RATS) - Wenonah, NJ - 609-468-5293
Joe Wdzieczkowski (no call ?)
300 Bell 103

(6809-FLEX) - Ringwood, NJ - 201-835-0161
Steve Robinson W2FPY
300 Bell 103

(OSI-6502) - Pluckemin, NJ 201-658-3087
Bill Ashby K2TKN
1200 Bell 212

(ABBS) - Marlton , NJ 609-983-5970 (1800-0900)
Midas Data Systems
300 Bell 103

We will start distribution to Wenonah,Little Falls ,Washington, and Marlton. Run the newsletter via the Little Falls RATS NEST on 220 Mhz and save a lot of grief. The 220 linkages available through the Cherryville group are outstanding. The rates for this will be at 1200 baud on a Bell 202 tone standard.

Anyone aware of a bulletin board in their area that will serve two or more packet enthusiasts please let me know and I'll add it to the list.

We request a ten dollar donation to get the newsletter off and running and keep it going. This will cover the mailings and phone calls (we will do much on the radio once we have the packet system going!) and the six or eight complimentry subscriptions to other groups. These are necessary to provide additonal input for our journal. Whatever is left over will go into the infamous repeater putter-uppers' slush fund.

We still however need input from our readers. There is no real shortage of material, but we need news and happenings. It is the primary purpose of this journal to fill in the gaps of the weekly nets. Since all can't be there for every session.

This month we have the long awaited article on the ad7i modem. Since Pauls work has entered into public domain we are now free to print his article. Part one this month and part two next month. We also have some hints and techniques for making your GDC-202 modem sing right. Bill K2TKN has given me a method to so around the strange handshaking that 202's seem to want.

I might add that Bill's group has run the GDC-202 into one of Gordon's Decwriters at 1200 baud and done massive core dumps, the Decwriter and the modem never dropped a character!

Don't forget we meet every Sunday at 2100 eastern time on 147.375/.975 Cherryville R.A. Please drop me a line or leave a message on WB2CAM'S bulletin board if you have any news, new persons, etc.

* * 220 MHZ BAND PLAN for PACKET RADIO * *

In the proceedings of the October 1981 AMRAD meeting on packet radio a band plan for 220 Mhz packet utilization was specified. It was as follows;

220.6/221.6 - full duplex packet repeater frequency pairs
220.7/221.7 -
220.8/221.8 -
220.9 - simplex and time diversity repeater frequencies
221.0 -
221.1 -
221.2 -
221.3 -
221.4 -
221.5 -

* * 144 MHZ FREQUENCY ALLOTMENTS TO DATE * *

As of this point the following frequencies have been opted for local digital communications;

144.93 - South Jersey - KA2BQE - Brian Riley
144.95 - East Jersey - AD7I - Paul Newland
145.01 - North Jersey - WB2CAM - Gordon Beattie

In addition there will be an audio level translator running at KA2BQE / W1BEL to take 144.93 simplex up to Cherryville repeater on 224.12/222.52 . This unit is awaiting crystal and we expect to have it running by early March. The piss are there, the control circuitry is under construction, and the antennae will go up shortly. Gordon WB2CAM is working on a 450 link repeater to tie his end into Cherryville, and the WA2SNA repeater should digitally inclined soon. It looks as if we will have the communications links for the whole state inplace within a few months. We bring up high speed ASCII communications as soon as the links are open, placing packet HDLC formatting on as the boards are built and working.

* * PACKET RADIO WORKSHOP at ARRL HQ on 3 Apr 82 * *

On Saturday the 3rd of April 1982, the ARRL will host a workshop conference on packet radio at the League Headquarters in Newington, Connecticut. Primary purpose of the meeting is to iron out, hopefully, once and for at least a while the protocol for the packet network system. While there will be an agenda for the meeting it is intended that this will be a working session, with all sides being heard. The Tucson group is going to try to send a representative.

There will probably be an informal hardware session where a number of active boards, including repeaters will be set up.

** REQUEST FOR EQUIPMENT INFORMATION

I have had a number of requests from new individuals concerning transceivers for packet use. It is coming on to the hamfest season here in the Northeast and many will be looking for some second hand crystal piss for packet conversion. I would like to solicit from all readers comments on any particular rig which is well suited or which is unsuited for conversion to packet use. I would urge any of our readers who have equipment for sale or swap to list it here, as the bulk of our readership here in New Jersey is in the process of gearing up. We are not charging any fees for advertising gear for sale, but any contributions from successful sales will be cheerfully accepted!

* * MODIFICATIONS FOR THE GDC-202 - get it up and run! *

*

The GDC-202-5B modems currently used by a large number of the New Jersey group can be finicky if you don't set them up right. Interfaced directly to a Vancouver TNC board they work fine on the digital end but the audio/rf interface is tricky. As far as signal transfer its OK. The audio in/out is handled through transformers expecting 600 ohms. They will take a 4-8 ohm speaker output from a tape or transciever, or the dynamic mike input just fine. The problem is to keep the RF out of the modem. Since the transformers allow you to float the signal - do that. Allow the shield of the audio cable, if thats what you use, to be grounded only at the transceiver. Now the GDC's come to us with a DAA cable on them. This is removed by disassembling the strain grommet and pulling up on the 13 pin linear connector. You the take a 28 pin IC socket and saw off one row of 14 connectors. Cut off the 14th leaving 13 pins. Then cut off the wire-wrap pins for all but positions 2,4,12, and 13. File off any parts protruding up. You may then attach your shielded cable or twisted pairs to 2 and 4 (transmitt audio) and 12 and 13 (receive audio).

All that's needed now is a T/R switch. This can be done with an NPN transistor, a couple of resistors, capacitors, a diode, and a reed relay. The reed relay is placed in series with a resistor between the collector and +12 volts, the transistor emitter is grounded. The base is connected to the RTS line through a 1 K ohm resistor. The base is brids to ground by a diode (banded end to base) to protect the BE junction when the RS232 swings negative. The diode is also bridged by a diode to protect the transistor from inductive spikes. The PTT line from the transceiver can then be grounded to transceiver common, via the relay contacts, thus preserving the modem ground from the transceiver ground.

The power requirements for this arrangement are negligible. The +12 can be drawn from the modem itself. The resistor in the relay line must be determined from the resistance of the relay coil and the voltage supply.

Another consideration in using the modem is the local copy function. For connection to the packet board you want this function disabled. However for RTTY like communications, i.e. terminal,modem, and transceiver, you would set up the terminal in full duplex, enable local copy, and set the digital character the modem received echoed back on the terminal. Sort of a pseudo echo.

Another possibility in the T/R switching is to use an opto-isolator , it will do the job in place of the relay. The circuit is the same with the diode half being in place of the relay coil. The diode protection isn't needed and the series resistor must be recalculated for the curren/voltage characteristics of the particular opto-isolator. I have detailed spec sheets on the 4n24-28 series opto-isolators. They are available with an SASE and an extra stamp donation for the cause.

* * VANCOUVER TNC TIPS

One mistake being made commonly (at least by me and a few others !) is the insertion of the program EPROMs. The 0000 EPROM goes in the right hand most socket (as you look at the board holding the DB25 connectors down). The remaining EPROMs go in in

order from right to left. (if you read Hebrew, this is second nature and no problem, but this poor Gentile botched it up!)

To debug this board and software is difficult. There is no monitor to force a look at what is going on. A cassete tape recorder and your mode are your next best friends after your frequency counter and DMM. A scope is always extremely valuable, but not everyone has one. The commercial modems have LED's for the important RS232 lines, so you can tell if the LIPM module initializes the HDLC port. The TIP initialization message is the next guide post. Finally the tape recorder is the final tool it will tell you when you are getting output, and what it is. The TEST mode of the TNC terminal mode provides a CWID beacon and a packet beacon. This is unmistakeable and will signal that you are in the home stretch. You may the obtain a cassette from someone else's packet board with a different call on it and use it to check the receiving capability of your board. Finally record your own packet output and give to another board. Then you are ready to go on the air.

* * PACKET RADIO RESOURCE MATERIALS * *

I have come into a large amount of resource material concerning packet radio. This is materials from San Francisco, Washington DC, Vancouver, Hamilton, Ottowa, Tucson and our own New Jersey Packet Radio Group. It includes extensive protocol discussions,and treatises. Hardware definitions, descriptions and schematics. Hardware and discrete component data sheets, Xeroxes of articles from various journals, newsletters from other groups, and a large number of items I class as general interest relating to packet radio. At this time it fills four thick three ring notebooks and is growing. I am attempting to catalog all of it and will publish a bibliography. Meanwhile if you are looking for material drop me a line via pony express, or on the Little Falls or Wenonah RATS boards. Both systems know me as BRIAN RILEY. For a reasonable donation to the , by now, infamous r p-u slush fund i'll copy what I have and send it along.

* * * * * * * * * *

73's de KA2BQE

(5)

Data and Clock Modem, Version One (DCM-1), Part I

by Paul Newland, ad7i
Post Office Box 205
Holmdel, New Jersey 07733-0205

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Introduction

This is a description of Data and Clock Modem, Version One (DCM-1), a new type of terminal unit for amateur radio. The circuitry has been decomposed into two parts: the Data Module (DM-1) and the Clock Module (CM-1). DM-1 has been designed to provide hooks to CM-1; CM-1 will be described in a companion article soon to be released. The combination of these two units form the DCM-1 system. Those of you who have already looked ahead to the schematic may see that DM-1 alone does not differ much from other terminal units that have recently been appearing in the ham literature, and you are right!. There isn't much difference between DM-1 and all the others. But before you cast this article aside, stay tuned at least until the features are presented.

Why Another New Terminal Unit

Radio amateurs have made use of data communications for many decades, but only recently have they had access to high speed data communications. In the past, amateur radio data communications consisted mostly of Frequency Shift Keying (FSK) using teleprinters operating at 45 bauds per second. Today, new data communications systems such as Packet Radio are under construction by radio amateurs, and most of these systems require equipment more complicated than the average RTTY system. If maximum performance is to be obtained from these new systems, new components, such as terminal units, are required. DM-1 combined with CM-1 is such a component; it offers the following features as a radio modem:

1. Provides standard EIA RS-232 synchronous/asynchronous DCE interface.
2. Provides digital and analog self test for both near and far end testing.
3. Provides clock recovery within the modem. HDLC controllers in terminal equipment do not require built-in clock recovery circuitry.
4. Provides NRZ - NRZI encoding/decoding via a strap option. It is compatible with HDLC controllers that do not have NRZI capabilities.
5. During RTS-CTS delay, demodulator transmits dotting data pattern to simplify far-end demodulator synchronization. Controllers do not need to send synchronization preamble before packet transmission.
6. Provides state indicator lamps for all important EIA leads.
7. Can use standard Bell 202, as well as Bell 113 or RTTY audio FSK tones.
8. Provides Single-Frequency (SF) tone detection for supervisory signaling.

Paul Newland, ad7i
DM-1
January 31, 1982

Most amateur packet radio systems make use of the International Standards Organization (ISO) High-level Data Link Control (HDLC) frame structure. DCM-1 has features and capabilities that make it ideally suited for such systems. Additionally the DM-1 can be used alone, without the Clock Module, for 'normal' asynchronous RTTY communications by modifying the frequency-determining components to work with conventional radio data systems.

What follows is a description of one half of the DCM-1 system: the Data Modem, DM-1.

Circuit Description

Refer to Figure 1, the schematic of the DM-1. There are some notations that I have used that may require some discussion. They are:

[]	denotes a connection between this circuit board and another board or interface connector.
RSx	denotes a low resistance strap (e.g., a wire or 2.7 ohm resistor) for selecting an option.
S-|X|-S	denotes an analog switch (e.g., U8a or U8b). When the control lead is more than VDD - 0.5 volts the S to S resistance is less than 1K ohms. When the control lead is less than 0.5 + VSS volts, the S to S resistance is more than 1G ohms (the PC board will have more leakage resistance than the switch).
⊓	denotes CMOS schmidt-trigger input.
⊠	denotes an indicator lamp tap.
!	denotes an active LOW signal.

The IRTS (Interface Request to Send) lead, when fed with an EIA* ON signal, will cause U4c to go LOW and the

radio transmitter to transmit. With U4c LOW both D1 and D2 are OFF allowing the two timers, U7c and U7d, to begin timing. When normal RTTY operation is used, RS6 is installed. This defeats the watchdog timer and the transmitter will remain active as long as the IRTS is HIGH. To make the watchdog timer operational, remove RS6 from the circuit.

When BRTS and U7d are LOW, D3 is ON and [Y4], the !PTT, is low, turning the transmitter ON. After a delay determined by R2, R3, and C1, CTS will go HIGH, sending ICTS (Interface Clear to Send) HIGH (RS5 should be installed), informing the terminal that it is clear to send data. If RS6 is removed, the watchdog will timeout following a delay determined by R4 and C2. This delay should be longer than the maximum required transmit time. After U7d goes high the ICTS goes low and !PTT goes HIGH, disabling the transmitter.

The transmit data are sent from the terminal to the modem on the ITXD (Interface Transmit Data) lead. RS1 or RS2 is installed, as needed, to provide the modulator with either normal or inverted data (RS1 is normally installed).

The digital data are applied to the modulator, U101 pin 9. When LOW, the frequency generated is determined by R106, R107, and C102. When HIGH, the frequency generated is determined by R104, R105, and C102. The amplitude of the audio signal output is determined by the amount of current injected into pin 3. The output will be about 60 mV RMS per kilo ohm of R103. The more resistance, the greater the output voltage. R110 reduces harmonic distortion in the output signal. Purists can use a pot.

R9, R10, and C3 form an attenuator-buffer for interfacing to the transmitter's microphone circuit. In

---

* EIA-RS-232 voltages are defined as follows:

Mark or OFF: more negative than -3.0 volts

Space or ON: more positive than +3.0 volts

normal operation, TEST is LOW turning U8a OFF and U8b ON. The radio receiver audio is routed to the demodulator via R11, R12, and C5.

The demodulator is constructed around the EXAR XR-2211 phase locked loop FSK demodulator, U201. The audio is coupled from the source to U201 through C201, a DC isolation capacitor. R208 serves no purpose other than providing a mechanism for tuning the PLL. C204 and R204 are used to smooth the output from the quadrature detector. When an audio carrier is detected, the !LOCK output is a current sink to ground and LOCK is an open circuit. During no signal conditions, the outputs are in their compliment state.

!LOCK, with U5b, informs the terminal when a data signal is being received. IDCD (Interface Data Carrier Detect) goes HIGH when receiving a data carrier from the radio.

R5 and U7c convert the 0-12 volt demodulator's data signal to 0-5 volts. When the CM is connected, neither RS3 or RS4 are included in the circuit. RS3 or RS4 are used to select either normal or inverted receive data (RS4 is installed normally). U5a converts the data to EIA voltage levels. U5d and U11a are used only when the CM is attached and will not be discussed further in this article. All the [Zx]s denote connections to the CM, if included; otherwise they are NO CONNECTIONs.

A 567 PLL* single tone decoder, U501, is used for the SF tone detector. C501, R501, D501, D502, and C502 process the radio audio going to the decoder. The diodes (which are GERMANIUM) limit the voltage to the chip to about 600 mV pk-pk. C504 and C503 are used for the PLL low pass filter and quadrature detector, respectively. R502, R503, and C505 set the PLL's free run frequency. R504 pulls up the open collector output of U501. When the decoder output is high, D6 is ON, and C12 is charged, U7f is LOW, U6d is HIGH, and U11b is LOW (inactive). When a tone is detected, the output

* PLL - Phase Locked Loop

of the chip goes LOW and D6 is OFF. C12 discharges though R13. If the output of the chip stays low and does not 'bounce', eventually C12 will discharge enough through R13 to cause U7f to go HIGH; the result of this will cause U11b to go high, indicating to the terminal equipment that a special condition has occurred. (This special condition might signal the terminal equipment to execute a 'hardware' reset.)

Construction

With low frequency circuits, almost any construction technique will work well. The bread-board was constructed on phenolic perforated board using wire-wrap sockets for the ICs, and T44 pins for the discrete components. By the time this article is published a PC board should be available; see the appendix.

Modulator and demodulator frequency and timing components should be selected from Tables 1 and 2. Only the 1200/2200 Hz at 1200 bps values listed in the tables have been tested. None of the other values have been tested; they were determined by calculation.

Table 1: Modem Components vs Frequency

Frequency Pair	Modulator		Demodulator		
	R105	R107	R201	R202	C204
1200/2200	33K	15K	47K	22K	22nF
1070/1270	39K	33K	150K	22K	100nF
2025/2225	18K	15K	220K	15K	100nF
2125/2295	15K	15K	270K	15K	100nF
2125/2975	15K	10K	56K	12K	22nF
1615/1785	22K	22K	270K	22K	100nF

Table 2: Modem Components vs Signaling Speed	
speed (bauds)	C205
50	47nF
125	22nF
300	10nF
1200	2.2nF

Testing and Adjustments

CTS timer — Place a 1 Hz bipolar square-wave signal on the IRTS lead (use +- 5 volts). Watch the BCTS lead with a scope and adjust the LOW to HIGH delay via R2 as needed to provide enough time for the transmitter to come to full power and to synchronize any clocks in the system before CTS goes HIGH. Remove the 1 Hz signal from IRTS.

Watchdog timer — No adjustment should be required. If the watchdog times out too soon, increase the value of C2.

Modulator — With a counter, measure the frequency of the signal at MAUDIO. Set R103 such that the counter displays a stable indication. Apply either positive or negative 5 volts to ITXD to cause TXMDATA to go low. Adjust the modulator to the Mark frequency with either R105 or R107 (only one will have effect). Toggle the polarity of the voltage on ITXD and adjust the other pot for the Space frequency. Adjust R103 to provide about 2 volts peak to peak on MAUDIO. Remove the signal from ITXD.

Demodulator — Short out R208 and lift one end of C204; then measure the free run frequency of the PLL at pin 3 of U201. Adjust R203 so the displayed frequency is the average of the mark and space frequencies. Reconnect C204 and remove the short from R208.

SF detector — Short out D502 and connect a frequency counter, via a high impedance probe, to TP501. Adjust R503 so the counter reads the same value as the SF tone required. (I use 697 Hz; that is easily generated from a Touch-Tone* generator.) Remove the probe and the short.

The values of R9, R10, R11, and R12 will vary from radio to radio. The values listed should work for most of the modern VHF FM transceivers on the market. If you need to juggle the values, leave R10 and R11 at their nominal values and adjust R9 and R12 to provide the proper amplitude signal.

The DM-1 is now tuned up and ready to go. No other adjustments should be needed.

Operation

Operation is straight-forward. Figure 2 shows how to hook your EIA RS-232 compatible terminal to the DM-1. Apply the power to the terminal and the DM-1. All lamps should be OFF. Have the terminal set RTS HIGH (if it isn't already); the RTS lamp should light, the transmitter should transmit, and the CTS lamp should light after a small delay. Keys typed on the terminal should modulate the transmitter and flash the TXD lamp. Drop the RTS and the transmitter should go off the air. When FSK tones are received by the radio, the DCD lamp should light; when the tones carry data, characters should print on the terminal as well as flash the RXD lamp.

* Touch-Tone is a registered trademark of American Telephone and Telegraph.

Some Comments on Performance

As with most high speed data modems, DCM-1 requires a quiet, flat audio spectrum bandwidth for good performance. Some amateurs who have used Bell 202 modems with radios have found it necessary to use an audio hi-fi equalizer in the audio circuits of their radios for the modems to work properly [1]. This is not surprising.

Consider the audio processing that takes place from microphone to speaker in an amateur radio VHF set. The transmit audio is pre-emphasized via an RC filter. Next, if a reactance modulator is used (this is the usual case), the signal passes through a stage of integration before modulation. At the receiver, the signal is detected (along with some not-so-white noise), then de-emphasized, and finally amplified for speaker driving. Although it is sometimes forgotten, the result of this audio processing is rarely perfect. The integrator reactance-modulator combination rarely yields perfect FM, and the pre-emphasis processing usually does not closely track de-emphasis processing. One result of these mismatches is that the transfer function, from microphone jack to speaker jack, is NOT a constant for all audio frequencies. Additionally, the transfer function will change whenever a different transmitter or receiver is used. All these factors make broadcast networks difficult to implement.

One test of this modem consisted of modulating a Kenwood TR-2400 with 1200 Hz and 2200 Hz tones of the same amplitude and detecting the signals with a Yaesu FT-227RA. The difference in speaker audio for these two different tones was greater than 6 dB, with 2200 Hz being the more poorly received signal. Again, all the above complications point to the requirement that good quality radios* be used.

* Good is a relative term. For example, I can't get 2200 Hz audio through my Motorola HT-220; the radio simply filters it out. Although not hi-fi, the HT-220 is considered to be a 'good' radio; however, it is not a 'good' radio for the purposes of data communications.

The net result of all this is that more experimentation must be done before any solid performance data can be reported. I am interested in hearing from others about their experiences using high speed modems over radio.

Conclusion

DM-1 provides an interface between a data terminal and amateur radio. When combined with CM-1, it becomes a full featured radio modem.

People with questions or problems concerning DM-1 are invited to contact the author at the above address; please include a S.A.S.E. if a reply is required.

References

[1] Private conversation with Steve Robinson, W2FPY, December 3, 1981.

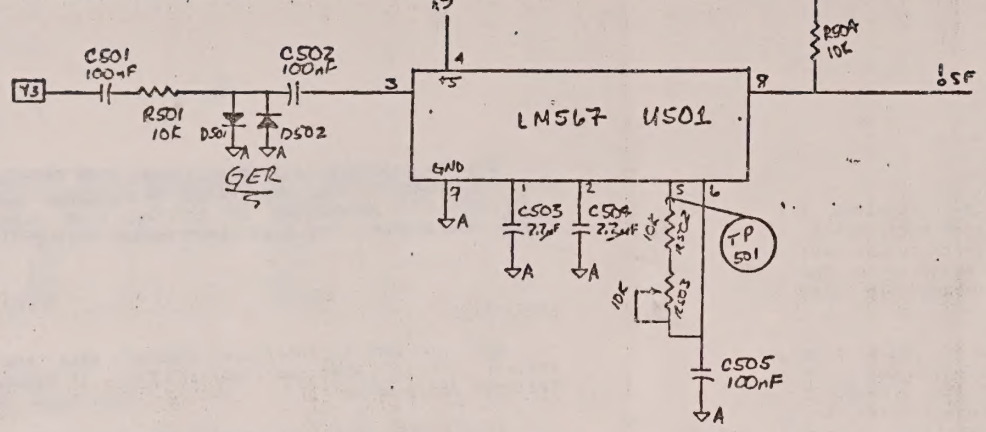

FIG 1c

D.4-1
SIGNED Paul Newland 1/6/82
WITNESSED AND UNDERSTOOD BY DATE

2S

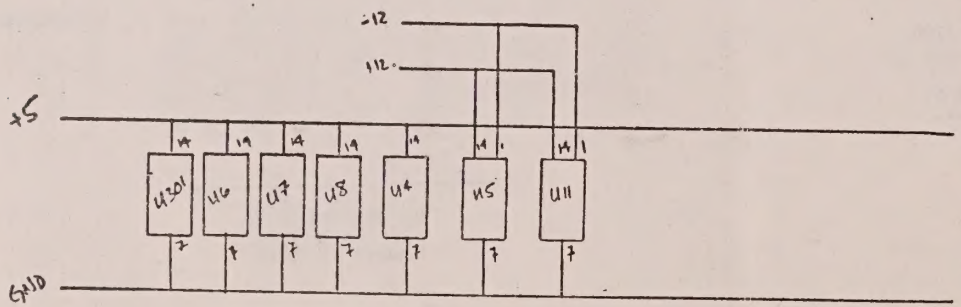

FIG 1f

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ISSUE 5 | SHEET 4

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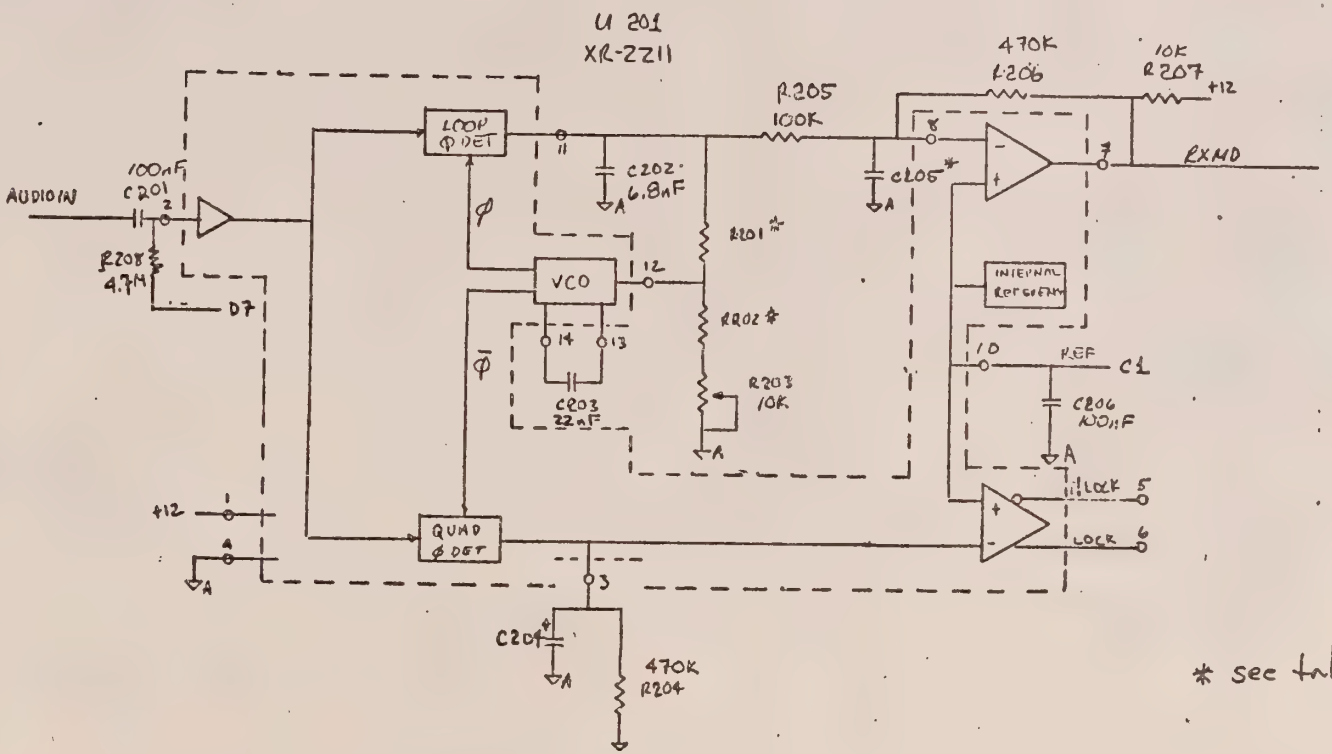

* see table 1 for values

FIG 1d

Paul Newland 1/1/91

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ISSUE 5	SHEET 3
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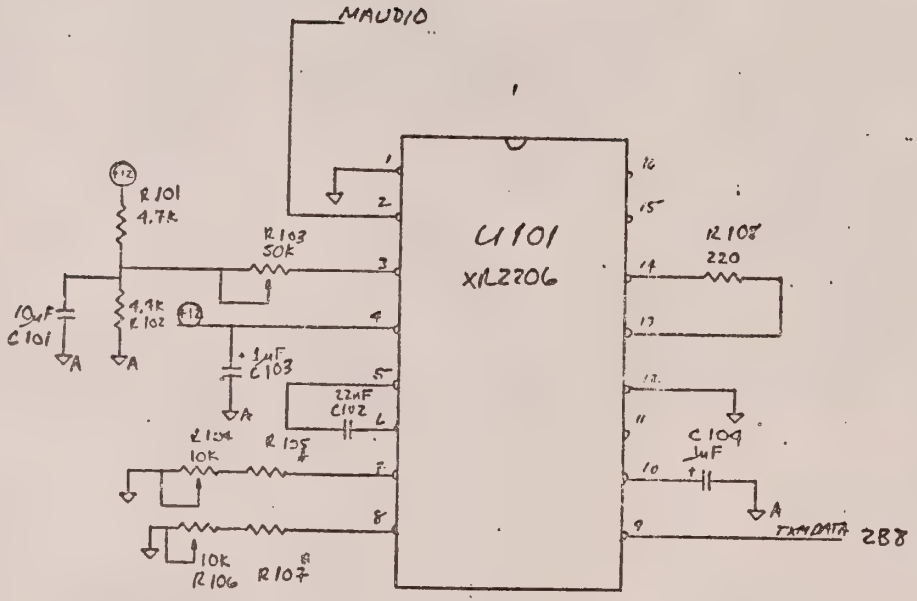

* see table 1 for values

FIG 1c

Modulator - analog	
SIGNED Paul Newland	DATE 1/31/82
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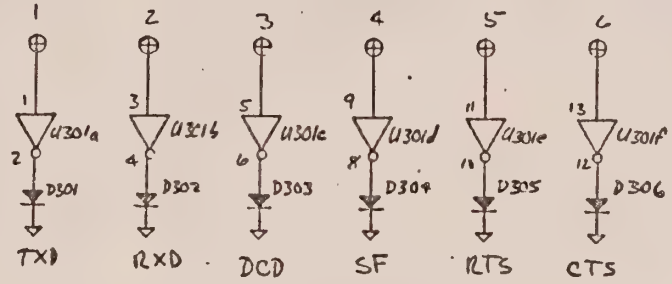
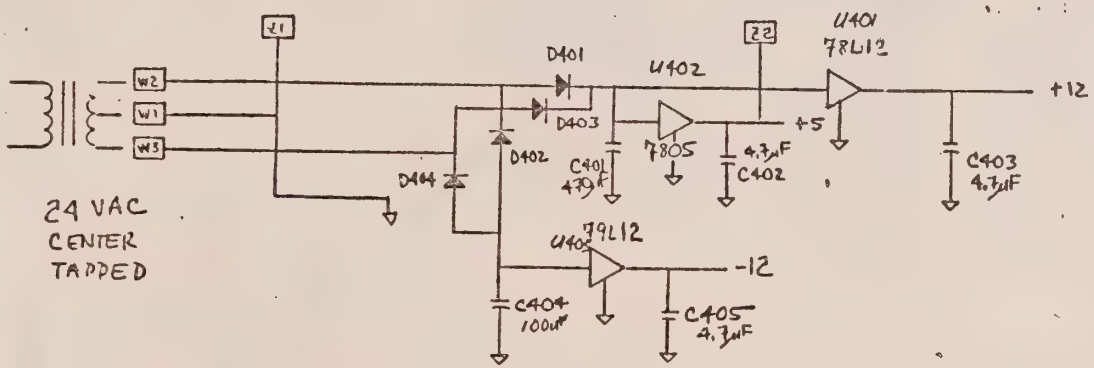
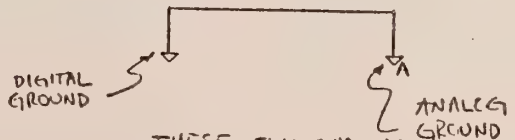
ISSUE E | SHEET 2

CODE OR DOCUMENT IDENTIFICATION
Power Supplies & Display REV 1-31-91







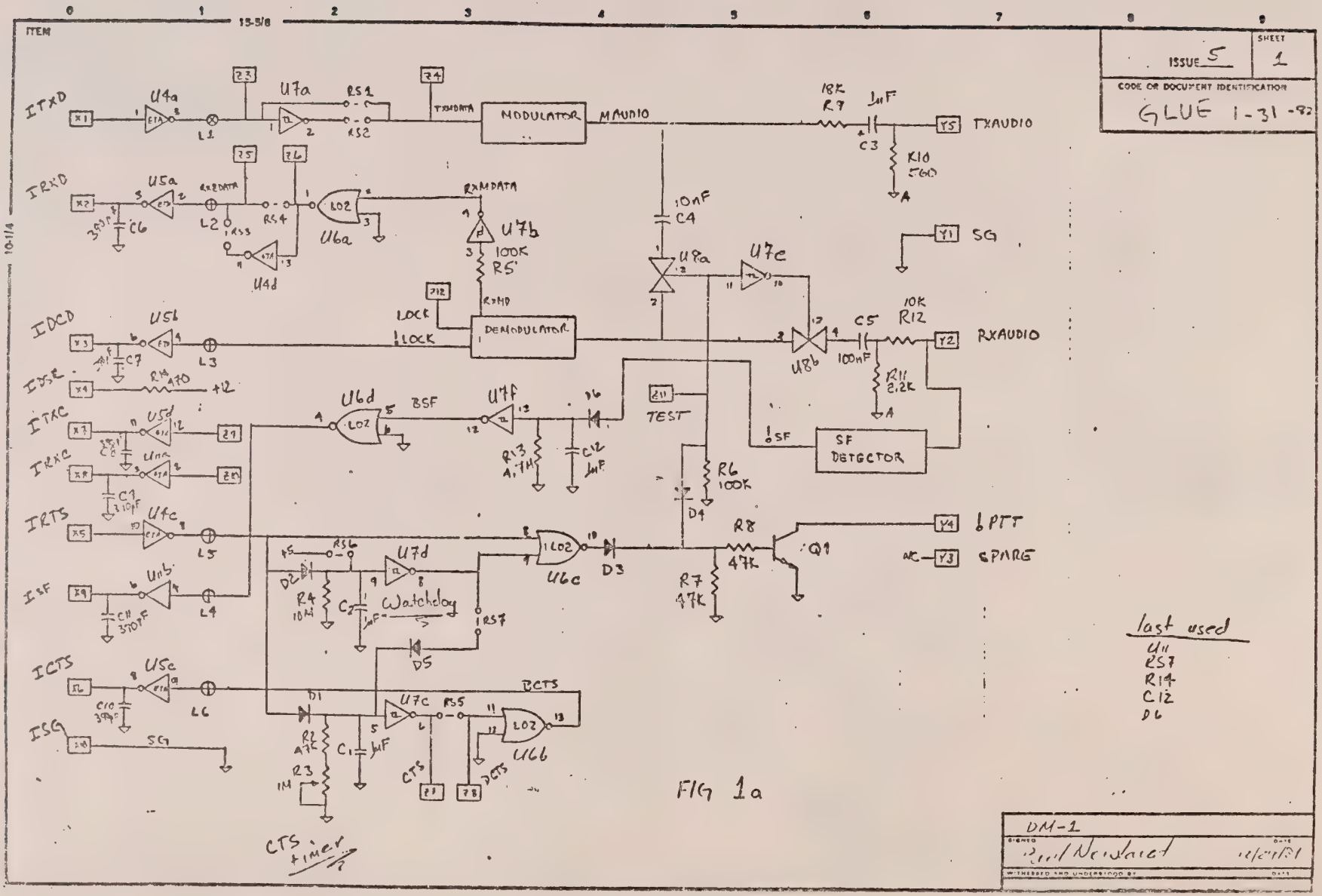
THESE TWO GROUNDS ARE CONNECTED TOGETHER WITH ONLY ONE CONNECTION.

FIG 16

DWG

SIGNED Paul Newland 12/30/91

WITNESSED AND UNDERSTOOD BY


ISSUE 5
SHEET 1
CODE OR DOCUMENT IDENTIFICATION
GLUE 1-31-92
ITXD
IRXD
IDCD
IRTS
ICTS
ISG
ITXC
IRXC
ISF
U4a
U5a
U5b
U5c
U5d
U5e
U5f
U4d
U7a
U7b
U7c
U7d
U6a
U6b
U6c
U6d
U6e
U6f
MODULATOR
MAUDIO
TXMDATA
RXMDATA
DEMODULATOR
LOCK
!LOCK
BSF
TEST
!SF
SF DETECTOR
Watchdog
BCTS
CTS timer
SG
TXAUDIO
RXAUDIO
!PTT
SPARE
Q1
D1
D2
D3
D4
D5
R1 47K
R2 47K
R3 1M
R4 10M
R5 100K
R6 100K
R7 47K
R8 47K
R9 18K
R10 560
R11 2.2K
R12 10K
R13 4.7K
C1 1µF
C2 1µF
C3 1µF
C4 10nF
C5 100nF
C6 330pF
C7 330pF
C8 330pF
C9 330pF
C10 330pF
C11 330pF
C12 1µF
RS1
RS2
RS3
RS4
RS5
RS6
RS7
L1
L2
L3
L4
L5
L6
+12
last used
U11
RS7
R14
C12
D6
DM-1
Fig 1a

Diodes

D501, D502	1N34A
D1, D2, D3, D4, D5, D6	1N4148
D401, D402, D403, D404	1N4002
D301, D302, D303, D304, D305, D306	LED, general purpose

Integrated Circuits

U6	74L02
U301	74L04
U8	CD4016
U4	DS1489
U5, U11	DS1488
U401	LM78L12
U402	LM7805
U403	LM79L05
U7	MM74C14
U201	XR-2211
U101	XR-2206

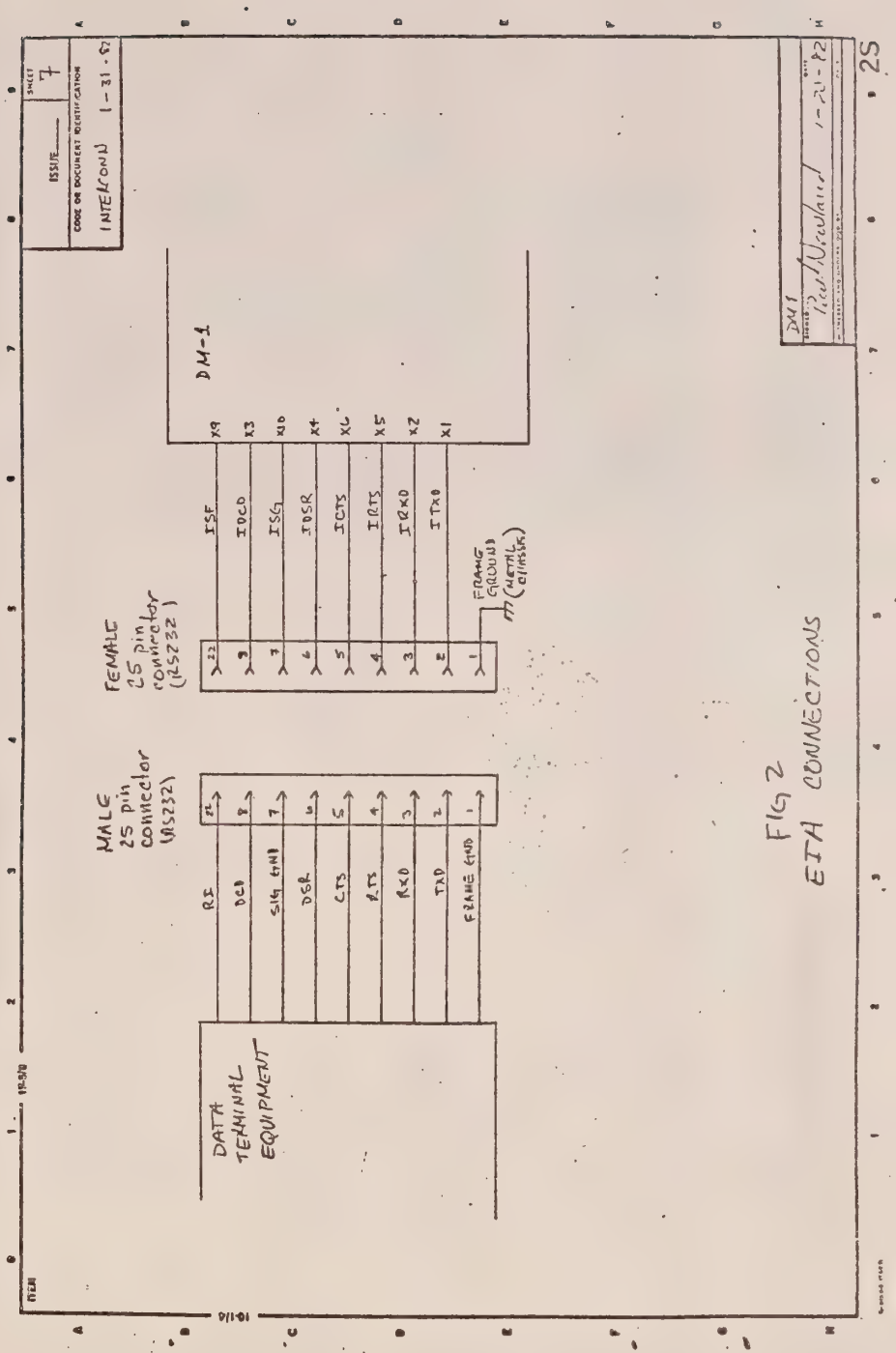
Transistors

Q1	2N6725 (darlington)

Connectors

X, Y, Z	16 pin DIP sockets, or other

Paul Newland, ad7i
DM-1
January 31, 1982



-- A P P E N D I X --

Sources

Parts maybe obtained from the following sources:

Jameco Electronics	1355 Shoreway Road, Belmont, CA 94002; 415-592-8097
Digi-Key Electronics	POB 677, Thief River Falls, MN 56701; 800-346-5144
Jade Computer Products	4901 West Rosecrans Ave, Hawthorne, CA 90250; 800-421-5500
Hanley Engineering	13400 Northup Way #22, Bellevue, WA 98005; 800-426-2668

Printed circuit boards are available from:

Jim Rhodes	1025 Ransome Lane, Kingsport, TN 37660

DM-1 Parts List

Resistors (1/4 watt, carbon 10%)

R1	not used
R105, R107, R201, R202	as required
R108	220
R10	560
R11	2.2K
R101, R102	4.7K
R12, R207, R501, R502, R504	10K
R9	18K
R2, R7, R8	47K
R5, R6, R205	100K
R204, R206	470K
R13, R208	4.7M
R4	10M
R104, R106, R203, R503	10K pot
R103	50K pot
R3	1M pot

Capacitors (16 working volts unless otherwise noted)

C204, C205	as required
C6, C7, C8, C9, C10, C11	390 pF disc
C202	6.8 nF Mylar
C4	10nF disc
C102, C203, C5, C201, C206, C501, C502	22nF mylar
C505	100nF disc
C1, C2, C3, C12, C103, C104	100nF mylar
C503, C504	1uF Tant or Elec
C402, C403, C405	2.2uF Tant or Elec
C101	4.7uF Tant or Elec
C404	10uF Electrolytic
C401	100uF Electrolytic, 25 Volts
	470uF Electrolytic, 25 Volts

TUCSON AREA PACKET HARDWARE DESCRIPTION AND SCHEMATICS

TAPR Hardware Report

This will be a regular feature of the TAPR column, the purpose of which is to disseminate information on the activities of the TAPR Hardware Group, presently headed by Lyle Johnson, WA7GXD.

The first major project is the TAPR TNC. It is a 6502-based, stand-alone device intended to act as an intelligent interface between a user and the LAN (Local Area Network). By way of introduction, the vital statistics follow:

CPU	6502
User I/O	(1) RS-232C-type Serial Port (50 Baud to 19,200 Baud)
	(1) TTL-compatible handshaking Parallel Port
LAN I/O	Western Digital 1933B-01 HDLC Controller, NRZI w/PLL
	On-board Bell-202-style 1200 Baud Modem
ROM	2k to 32k EPROM in 28-pin JEDEC Byte-wide Sockets
	(initial version populated with 12k of 2732 EPROM)
RAM	2k to 8k Static, in 28-pin JEDEC Byte-wide Sockets
	(initial version populated with 4k of 2016 SRAM)
	(can go to 40k when 8k Byte-wide parts are available)
Size	Approx 5" by 8" PC Board
Power Supply	+/- 12 volt and +5 volt, regulated, on-board
	(Power transformer, 5-volt chip and capacitor off-board)
Special	On-board 256-bit EEPROM for user interface customizing
	On-board calibration of MODEM to +/- 5 Hz
	Complete self-test at power-up, including RAM bit-test
	Hardware Watch-dog timer on Transmitter PTT-line
	User Custom Wire-Wrap area provided
	Status LEDs provided for Modem Cal, Rcvr Level Set,
	Xmtr Key, CWID
	Dynamic allocation of memory based on Self-test results
	On-board FORTH-like language for rapid software changing
	Capability for down-loading of Software
	Simple PROM Address-decoder for mixing of memory chips
	RAM/ROM ratio variable due to Byte-wide Socket design
	[There are six (6) 28-pin Byte-wide Sockets on-board.]
	Boards are wave-soldered with ALL ICs socketed
	Complete Documentation!
Price	ESTIMATES are as follows
	PC Board $ 25-30
	PC Board Parts $105 (includes 12k EPROM, 4k SRAM)
	Cabinet, etc $ 35
	(Note that some of the PC Board Parts will be shifted to the PC Board cost as these parts will be wave-soldered onto the board.)

During the next few months this column will highlight some of the unusual and advanced features that make the TAPR TNC the logical choice for Local Area Networks.

This month's highlight is the user configuration system hardware.

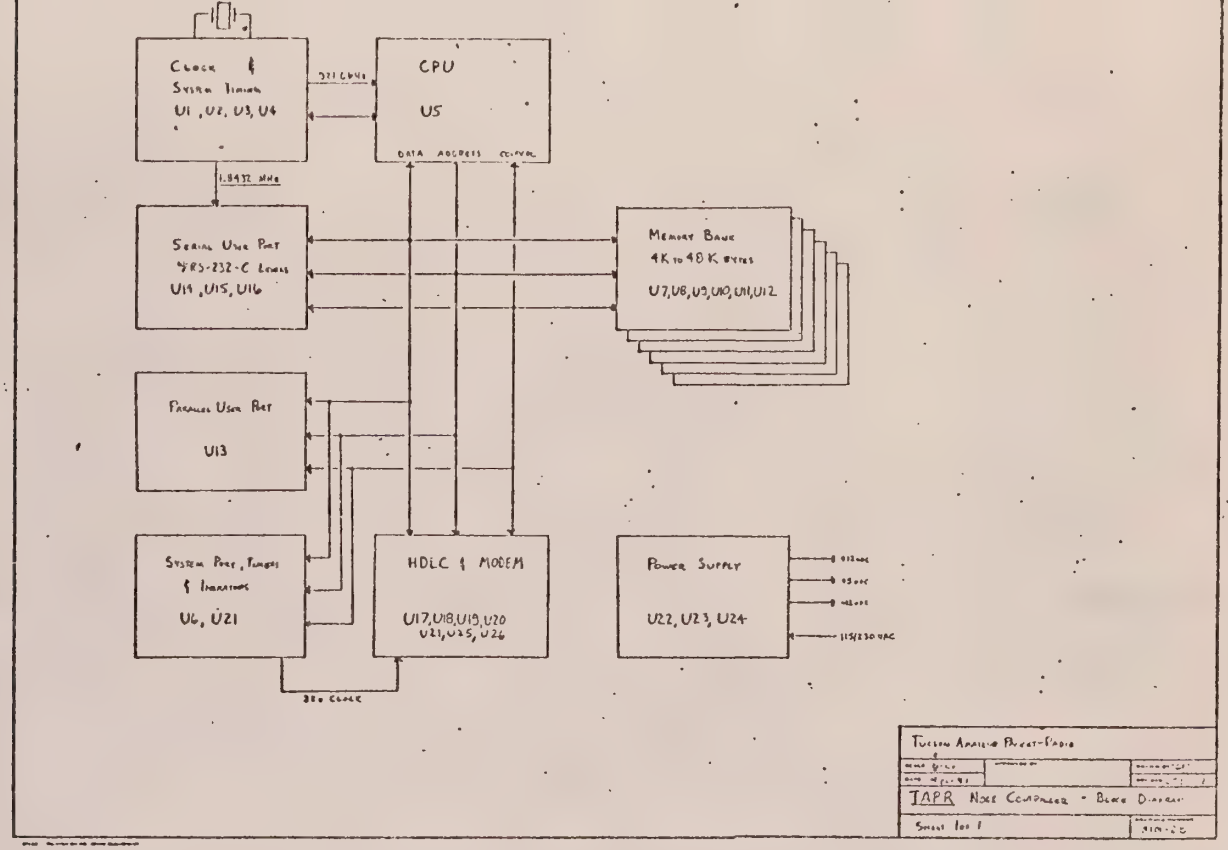
3 DIP-switches are provided to select word length (7 or 8 bits), Parity (on or off) and Parity Sense (odd or even). At power-up, the TNC checks the EEPROM to see if it has been programmed. If not, the DIP-switches are read. Then the TNC checks the Serial and Parallel ports for the character 'U' (55 hex). If not found, the baud rate in the Serial port is decremented and the process repeated. This continues until 'U' is found. The TNC then activates the sign-on procedure through the serial or parallel port, as appropriate.

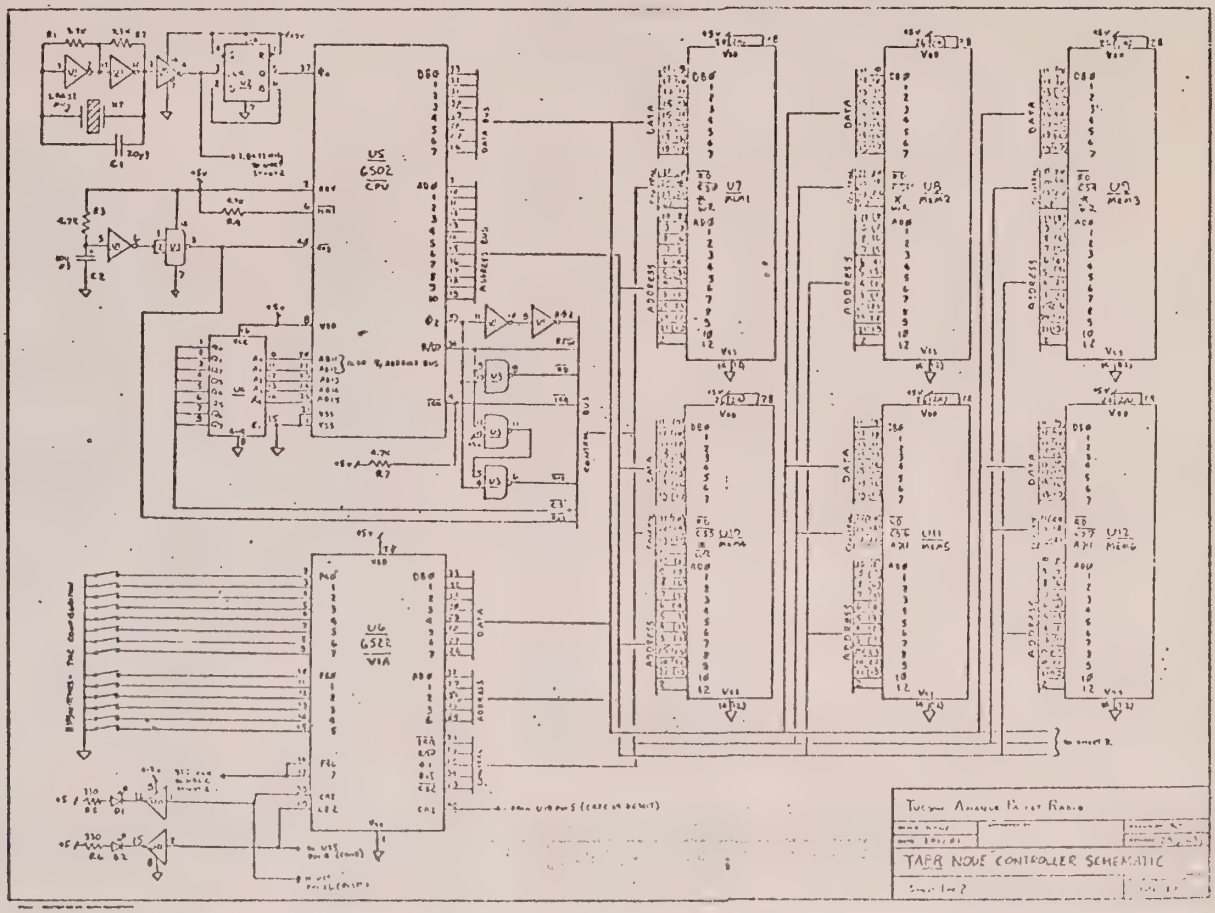
If the EEPROM has been initialized, the default port configuration will be read. Such things as Callsign, Baud Rate, Terminal Width (20 to 132 Columns), Echo/No-echo, BS and DEL handling, Control-Q/S/U handling, and so forth, are user-alterable in the EEPROM, either as temporary settings (power-on default not altered) or as 'Permanent' settings (power-on default updated). It even has a bit to tell the TNC if it should list the default settings at power-on or not (useful for Bulletin-Board style users who want everything set up at default and don't like to answer questions). This gives the convenience of default allocation of parameters with the flexibility of user-alteration of those settings. We feel it is the best of both worlds.

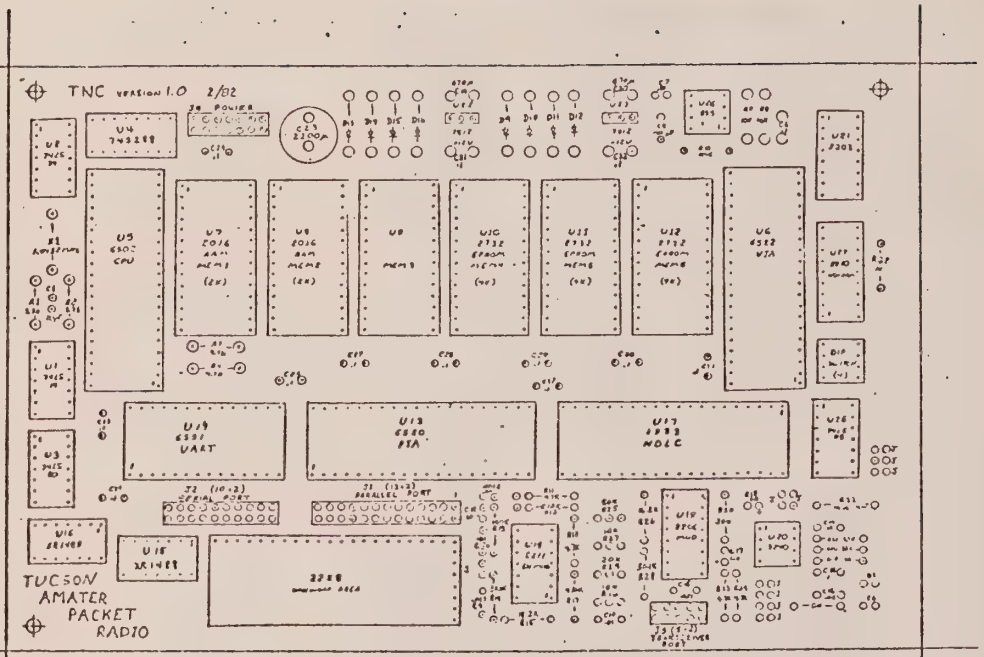
Next month: self-test, calibration and diagnostic features.

Please write and let us know what you think. We want the TAPR TNC to reflect the experience of all Packeteers, and all comments and questions are welcome. Mail all correspondence to the address listed at the beginning of this column (SASE please-if you want a direct reply). We are also soliciting inputs for major project number two - a VHF/UHF Packet RF board - now in the preliminary planning stage.

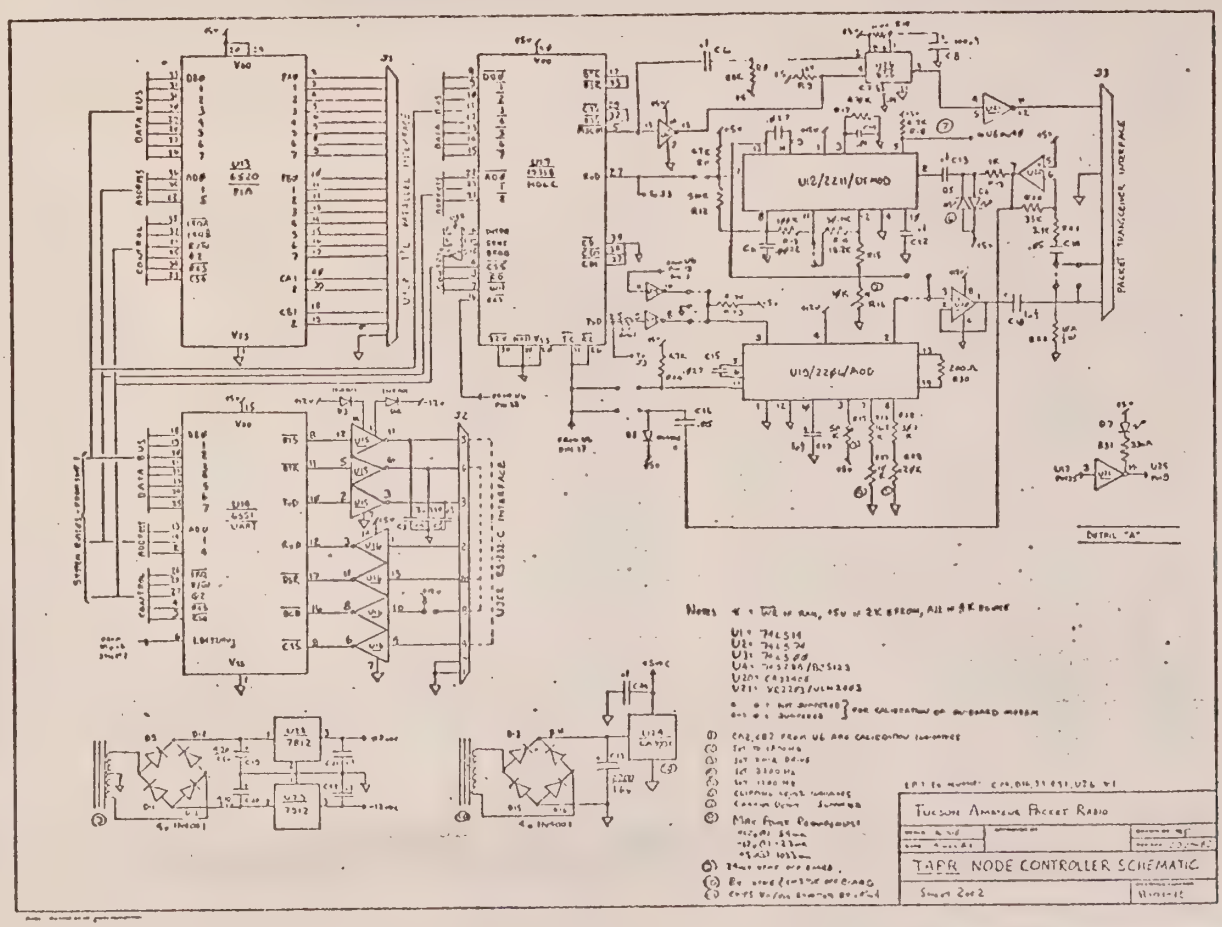
If anyone needs larger scale detailed reproductions of these schematics contact KA2BQE with an SASE and a small donation to the "fund".


Clock & System Timer
U1, U2, U3, U4
CPU
U5
DATA ADDRESS CONTROL
1.8432 MHz
Serial User Port
RS-232-C Levels
U14, U15, U16
Memory Bank
4K to 40K bytes
U7, U8, U9, U10, U11, U12
Parallel User Port
U13
System Port, Timers & Interrupts
U6, U21
HDLC & MODEM
U17, U18, U19, U20
U21, U25, U26
Power Supply
U22, U23, U24
+12VDC
+5VDC
-12VDC
115/230 VAC
38.4 CLOCK
Tucson Amateur Packet Radio
TAPR Node Computer - Block Diagram


U5
6502
CPU
U6
6522
VIA
U7
U8
U9
U10
U11
U12
Tucson Amateur Packet Radio
TAPR Node Controller Schematic



Component Layout
Tucson Amateur Packet Radio
Terminal Node Controller



OTTOWA HARDWARE DESCRIPTION + PROTOCOLS

VE3OIE et al

An Alternative Telecommunication System

The current telecommunication systems (telephone, telegraph, television, etc.) have certain characteristics in common: they are large; expensive to establish; expensive to maintain; usually operated by monopolies (or virtual monopolies in the case of highly-regulated television stations, for example).

Opportunities for individual involvement in the creation of current systems are almost non-existant, and in any event, the cost would be prohibitive.

Any alternative system should therefore encourage individual participation, both as provider and user, and be relatively very inexpensive. Certain characteristics then immediately come to mind, such as simple design, flexibility, use of local materials, and so on. Depending on local requirements, the system should be designed to maximize or minimize human involvement in operations.

The following description outlines a telecommunication system that provides an alternative to some features of current commercial ones.

Digipeater

Digipeater was born in June, 1979, and was operational in April, 1980. It principally involved the work of three amateur radio operators who are also computer enthusiasts: Larry Kayser, Stan Kazmiruk and Hugh Pett. They exploited the segment of the 220 Mhz Amateur band recently set aside for "packet radio" by the Canadian Department of Communications, whose regulations were deliberately left broad in order to encourage experimentation.

The three developed a (very shaky) demonstration in less than a month, and then proceded to put together an operational version. From the beginning, the design criteria included simplicity, moderate cost, state-of-the-art, equal access, a transmitted polling control program, and central operational control. The parameters selected were:

1) data rate: 9600bps
2) transmission mode: frequency shift keying; simplex
3) transmission frequency: 222.34Mhz
4) maximum signal bandwidth: 25Khz
5) interconnection of components: RS-232
6) transmitter power: 1 watt

The design required a signal repeater, through which all transmissions would pass; this repeater was to operate in a polling mode, in order to permit orderly use of the facility. Polling was chosen because uncontrolled systems (such as "Aloha") are apt to collapse when even a fairly small number of users (say 15) wish to transmit at the same time. The hope was that Digipeater would not collapse with even 200 users wishing to transmit.

An early examination of the system showed that the polling scheme would be very inefficient, if standard radio equipment were used. The cause was the long (up to 150 milliseconds) time such equipment required to switch between transmitting and receiving. Computer simulations showed that for polling to achieve even 50% of the theoretical efficiency, a switching time less than 15 milliseconds was required, and in fact, the faster the better. What was eventually achieved, using a device known as a "PIN diode", was 1.4 milliseconds; this speed also required modifications to the transmitter and receiver.

Operation

Initial tests consisted of simulated polling, with no reception. Signal strength was measured at various distances, and confirmed that distances up to 10km would be possible with very simple antennas. It showed also that a high site for the repeater would be very desirable, in order to extend coverage out to perhaps 50km.

An interim site for the repeater (on a 12-story office building) was occupied in April, and the first successful transmission of the polling program over a long distance was accomplished. After some antenna work, the control station (which transmits the polling program to the repeater) was fully operational, at a distance of 20km.

The primary control station (there are currently two) runs on an uninterruptible power supply, to ensure that the repeater can always obtain its program. Program transmission occurs after a power failure at the repeater site, on command from the control station, and about every 10 days when a counter in the polling program reaches a pre-set number of packets sent.

Costs

Completely packaged, with power supplies, the transmitter and receiver cost (in total) about $300.00 . Because of the tranmission speed invloved, each station must be computer-controlled. The repeater currently uses a six-year-old 8080-based system, and the control stations use Heathkit H-8 computers. It was apparent from the beginning that dedicating expensive H-8 type hardware to the network was prohibitively expensive.

A small local firm, Warren Instrotech Ltd., undertook the task of creating a single-board computer that could be used as either a repeater controller, or a user station controller. In this latter service, it would have two RS-232 ports, one for the network, and one for a "user terminal" device. This terminal could be just that, any ASCII device such as a Teletype RSR33, or a "glass teletype". But it could also be a larger computer, with file storage capability, etc.

The single-board computer is available for $275.00, including the software (in an EPROM) required to connect to the network.

Terminals can be assembled for about $300.00, and purchased for about $1000.

The total cost for a station can thus be under $1000, and this does not include any donated parts, or quantity discounts. The cost of a repeater is even less, since no terminal is required.

Maintenance/Power

All the components are designed to be reliable, and maintenance-free. The design of the receiver includes a circuit to compensate for signals that are somewhat off-frequency (+/-2Khz), and no moving parts are used. The low power requirement (30 watts) makes intermittently-charged battery operation feasible, including by solar-cell arrays.

It would be straight-forward to use very-low-power computer electronics to reduce power consumption to less than 4 watts for a repeater.

Computer Programs

There are four programs required to operate the Digipeater network:

1) BOOTLOADER - this program resides permanently in the repeater controller, and loads the polling program over the radio link.
2) DPCTLPGM - DigiPeater ConTroL PrograM: this is the polling program that controls the network during normal operation; it is sent by the Control Sender program to the repeater.
3) CTLSNDR - ConTroL SeNDeR: this is the control station program that sends DPCTLPGM to the repeater, and that can command DPCTLPGM.
4) TERMINAL - this program resides in a user's equipment, to allow access to the network.

Of these four, DPCTLPGM and TERMINAL can have a number of variants. For example, it may be desirable to experiment with different network timing parameters: a different version of DPCTLPGM could be commanded into the repeater, tests conducted, then the original program re-instated. Or, possibly, a special network with different users could be established to deal with a local emergency. This feature of network adaptability (in a matter of 30 seconds) is Digipeater's most innovative.

Different TERMINAL programs could connect totally disparate types of terminal equipment, even including such things as voice encoders/synthesizers, facsimile, and monitoring systems. The different programs could also deal with sequential arrival of messages, storage in file systems, equipment activation (warning lights, etc.) and automatic response to queries.

THE FUTURE

Already, the next stage in the development of the system is underway. The packet radio group in Montreal, Quebec has had a system in operation for nearly a year, using a very different protocol. In the near future (fall, 1980), from good sites (west of Montreal, and a 26-story Ottawa office tower), it is hoped to link the two systems. About the same time, a different radio link at approximately 14.076Mhz will begin testing. This HF link will initially join Vancouver, Saskatoon and Ottawa, with a prospect of bringing in more areas afterwards.

Looking even further into the future, it is likely that large concentrations of users will result in specialized networks, such as for voice, or monitoring, etc. With some planning and cooperation, these diverse networks will be able to interconnect, allowing users access to all facilities on an occasional basis. Different protocols and technical parameters will be experimented with, and improved networks will hopefully result.

Network Uses

The Digipeater network operates as a common carrier for radio amateurs. The messages (packets) on the network are routed to their destinations, acknowledged and obliterated. The network has absolutely no interest in the contents of the data being transferred. This means that simply having the network, running, is of very little value. What has value is the collection of ways in which the network is used; this is decided by the network users.

What is expected to happen is that users interested in a certain activity will define their own rules (a protocol!) for carrying it on. They will either keep it private among themselves, or they may make public their rules. This would allow anyone to participate in their activity. The radio link across the country is an example of such a "public" activity: any network user who follows the rules will be able to send messages around Canada, and eventually, perhaps, around the world.

An early public activity in Ottawa will be the use of a large, sophisticated computer-assisted communication (computer conferencing) system, operating on a large mainframe. Network users will be able to participate in the same manner that they would on a time-sharing computer.

Yet another public activity will be the use of the network by non-amateurs, who will use the telephone system to leave a message at a network station, and pick up a reply later. This will be permissible under "third-party traffic" rules for amateur radio; the principle such rule is that no charge may be made for handling messages (traffic). Perhaps some day many people will be able to send messages almost anywhere in the world, and by law it will have to be free.

Far, Far Out

The use of standard radio links (in the high-frequency range of 3-30Mhz) is workable, but not overly reliable, and never guaranteed at the moment needed. The laws of HF radio propagation require that certain fluctuating conditions combine, if communication over long distances is to proceed.

In the commercial world, the reliability problem has been tackled by means of cables (and the land microwave relay equivalents) and satellites. Cables are very costly, far beyond the means of even a collective effort of all amateurs worldwide. But radio amateurs have built and flown a dozen satellites, piggybacked on larger commercial satellites.

A satellite specifically designed for use as a digital signal relay is now being discussed. Such a capability would greatly improve the reliability of long-distance communication among radio amateurs.

In Conclusion

Communication systems by themselves have no value. They must be used, to be valuable, and the uses to which we put them reflect strongly our own characteristics, good and bad.

The system just described is intended to be a "grass-roots" affair, encouraging wide participation, in the hope that better interpersonal communications will enrich individual lives, give meaning where there was aimlessness, and encourage hope that people count. This is a growing system, by many, involving many, and for many.

APPENDIX A

Uses of Digipeater already considered

1) text messages from one user to another
2) text messages from one user to several others
3) text files sent (as multiple messages) from one user to another
4) computer programs sent (as multiple messages) from one user to another
5) monitoring signals between two stations belonging to the same user
6) monitoring signals from one user to another
7) experiments in digitized voice, at various sampling frequencies and amplitude resolutions
8) graphics files (using techniques such as Telidon)
9) access to specialized services, such as simulation packages, long-distance relays, computer conferencing, and community bulletin boards

Each use above can have many applications. For example, text messages from one to several users could advertise surplus gear for sale, or arrange a meeting, or register a change of address or telephone number. Similarly, monitoring could keep a summer home under surveillance during the winter (or a primary residence during the summer), or could provide an emergency link for high-risk patients to a central facility.

APPENDIX B

Initial Protocol for Ottawa Packet Radio

Purpose

This protocol is intended to be a medium-efficiency, easily implemented protocol. It will be used on the Ottawa Packet Radio repeater VE3RMR until a new protocol is agreed on by users of VE3RMR.

General Description

This is a polling protocol, operated by the stored program controller at VE3RMR.

The control program (CP) contains a list of amateur licence callsigns which may use the repeater. Any licenced amateur is permitted access, by prior arrangement.

The CP polls each callsign in its list, in turn, requesting traffic. Traffic consists of a packet, in a standard format.

The called station does one of two things: sends traffic, or remains silent.

A further mode of access, using a general poll, is under development.

When a station sends traffic, it is labelled "active" by the CP (the concept of "active" is explained later). Each time an "active" station remains silent, its "active" label is "eroded". Eventually, after a number of silent responses, an "active" station has its label completely "eroded", and then is labelled "inactive". Erosion of an active label also occurs (VERY rapidly) if a station uses an invalid address on a packet, or continually tries to send to a station that doesn't respond.

Each packet that a station sends is acknowledged by VE3RMR, in one of the following ways:

1) accepted by the addressed station (ACK)
2) not accepted by the addressed station (NAK)
3) addressed station did not reply (NOTAVL)
4) bad address used (BADADR)
5) refused by the addressed station (REFUSED)

If a packet is ACKed, the sender is labelled fully "active", and the addressed station is labelled fully "active". In all other cases, the sender's "active" label is eroded, by varying amounts depending on the severity of the problem.

Active vs. Inactive

The only difference between an active and an inactive user is that active users get polled more frequently for traffic. As an example, a CP with 100 callsigns might poll each inactive callsign once every 6 seconds, but would be polling each of 10 active callsigns once every 2 seconds.

This scheme adapts to the load, allowing everyone access within a guaranteed and reasonable time span, while sharing the channel equally among those stations sending traffic regularly. In the extreme case, of all callsigns being active, each would be polled at least every N/2 seconds, where N is the number of valid callsigns.

Each user may send up to 240 characcers of data each time he is polled, to any other valid callsign. Each user is responsible for ensuring that his station program can deal with arriving packets, refusing some if necessary (for example, if he is receiving a lot of connected data from one user, he probably would not want any other data in the middle.)

It is certain that application-oriented protocols will be defined to facilitate specialized tasks, such as file transfers. These would in effect redefine the 240-byte data area, and would be used by those wishing that function. The basic repeater protocol will remain as simple as possible, in order to allow many different uses.

echnical Description

There are 9 types of packet. Each has a fixed-format header of 16 bytes. A traffic packet has an additional data area of 0 to 240 bytes. The maximum length of a packet is therefore 256 bytes.

ype	Name	Length
1	refused to accept (REFUSED)	16
2	traffic (transmitted by user)	16-256
3	bad address (BADADR)	16
4	traffic (transmitted by repeater)	16-256
5	not accepted (NAK)	16
6	accepted (ACK)	16
7	reception shutoff (SHUTOFF)	16
8	not available (no reply) (NOTAVL)	16
9	request traffic	16

acket Preamble

To allow for transmit/receive switching, power on, etc., each acket is immediately preceded by from 2 to 6 synchronizing characters hex FF) and a hex 00. The precise number of sync characters recommended ill be determined experimentally during early operational use.

acket Format

Byte	Name	Description
1	length	the length of the packet, less 1 (maximum 255)
2	type	the packet type (1 through 9)
3to8	address	the call sign of the station to which the packet is being sent
9to14	sender	the call sign of the station from which the packet is being sent
15,16	CRC	the 16-bit CRC for the entire packet
17-256	data	traffic packets may have from 0 to 240 bytes of data

otes

1) the first two bytes are binary, all eight bits valid.
2) bytes 3 through 14 are standard ASCII, with high-order bit=0.
3) bytes 15 and 16 (CRC) are binary, all eight bits valid.
4) data is assumed to be binary, all eight bits valid.

Packet Sequences

Normal Traffic Sequence

1) VE3RMR sends type 9 packet to station1
2) station1 sends type 2 packet, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 sends type 6 to VE3RMR
5) VE3RMR sends type 6 to station1

No Traffic Sequence

1) VE3RMR sends type 9 to station1
2) station1 remains silent. After about 10 msec. VE3RMR proceeds to poll the next callsign.

Bad Address Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR does not find "station2" in its table of callsigns, and sends type 3 to station1

Refused Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 sends type 1 to VE3RMR
5) VE3RMR sends type 1 to station1

Not Available Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) VE3RMR waits a short time (10msec.), but receives no reply
5) VE3RMR sends type 8 to station1

Not Accepted Sequence

1) VE3RMR sends type 9 to station1
2) station1 sends type 2, addressed "station2"
3) VE3RMR changes type to 4, sends it
4) station2 detects an error, sends type 5 to VE3RMR
5) VE3RMR resends type 4 to station2
6) station2 detects an error, sends type 5 to VE3RMR
7) VE3RMR resends type 4 to station2
8) station2 detects an error, sends type 5 to VE3RMR
9) VE3RMR sends type 7 to station2
10) VE3RMR sends type 5 to station1